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MANUFACTURING METHODS AND TECHNOLOGY (MMTE) MEASURE FOR FABRICA--ETC(U)
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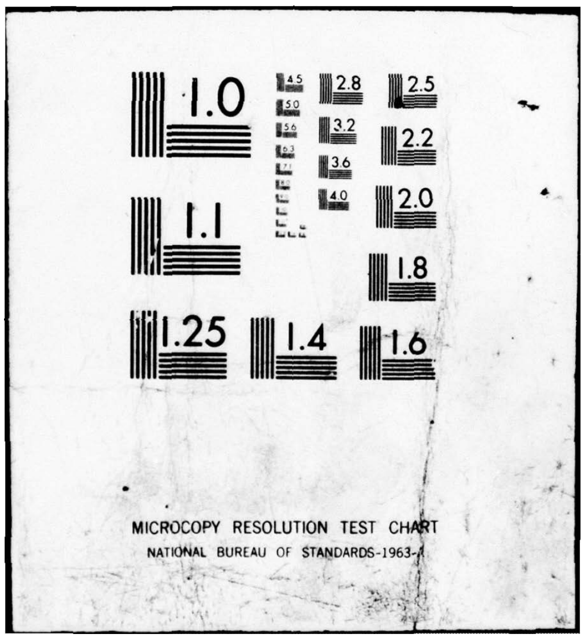
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FOURTH AND FIFTH QUARTERLY PROGRESS REPORT

FOR

MANUFACTURING METHODS AND TECHNOLOGY (MMTE)

MEASURE FOR FABRICATION OF LOW VOLTAGE

START SEALED BEAM ARC LAMPS

36189
37751

1 March 1977 to 30 September 1977

CONTRACT NO. DAAB07-76-C-0034

U.S. Army Electronics Command
Production Division
Production Integration Branch
Ft. Monmouth, NJ 07703

Varian Associates
EIMAC Division
301 Industrial Way
San Carlos, CA 94070

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A program is in progress to establish a production capability for the purpose of meeting estimated military needs for the X6335, a 1kW sealed beam xenon arc lamp with low voltage starting mechanism.

In accordance with the requirements of the contract, the third engineering sample is still undergoing fabrication to meet specification.

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Block 20 Continued

Improvements were made to reduce manufacturing costs and improve reliability. These included:

a. Sapphire window assembly seal redesigned to reduce high stress levels.

b. Self-fixturing for brazing wherever possible.

c. Porosity problems minimized.

d. Body diameter smaller in size to reduce lamp and fixturing costs.

e. Method of attaching cathode improved to minimize the number of parts required and to reduce the number of braze cycles necessary to complete the assembly.

f. Stinger mechanism redesigned to improve reliability.

MANUFACTURING METHODS AND TECHNOLOGY (MMTE) MEASURE FOR FABRICATION OF LOW VOLTAGE START SEALED BEAM ARC LAMPS

FOURTH AND FIFTH QUARTERLY PROGRESS REPORT

1 March 1977 to 30 September 1977

"The objective of this manufacturing methods and technology project is to establish the technology and capability to fabricate Low Voltage Start Sealed Beam Arc Lamps".

CONTRACT NO. DAAB07-76-C-0034

By

Roy Roberts
Tim Bell

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ABSTRACT

A program is in progress to establish a production capability for the purpose of meeting estimated military needs for the X6335, a 1kW sealed beam xenon arc lamp with a low voltage starting mechanism.

In accordance with the requirements of the contract, the third engineering sample is still undergoing fabrication to meet specifications.

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1.0 PURPOSE

The objective of this program is to establish a production capability for the purpose of meeting estimated military needs for a period of two (2) years after completion of the contract, and to establish plans which may be used to meet expanded requirements.

The program is intended to demonstrate and to "prove-out" the manufacturing processes, methods and techniques that are utilized in the production of 1kW sealed beam xenon arc lamps with a low voltage starting mechanism.

The lamp initially chosen for the program was the X6257. This lamps was developed for military search-light applications. The high voltage version of this lamp was developed initially under Contract Number DAA02-68-C-0215. The 1kW lamp was further refined on a PEM Contract Number DAAB05-71-C-2609. The low voltage starting X6257 was not developed with government funds, but was developed with Varian funds.

This contract is divided into three phases:

1. Engineering Samples, wherein modifications are being made to designs arrived at under previous development in order to improve their optical performance, safety and utility in the field and to reduce their cost. Production drawings, procedures, and tooling will also be developed. These parameters will be based on delivery of three (3) samples.
2. Confirmatory Samples, wherein the delivery of three

(3) units will be made to demonstrate that lamps can be made with production techniques and procedures to meet the specification.

3. Pilot run, wherein the delivery of thirty (30) units will be made to demonstrate the capability of meeting the planned production rate.

The engineering sample phase is needed to incorporate features which will make the lamp start more reliably, be easier to fabricate, be safer to operate, have a highly accurate mounting surface for optical reference and afford cost reduction.

During this quarter the 3rd Engineering Sample underwent improvements to enhance starting reliability of the lamp and to reduce highly stressed seal areas. Assembly was simplified by the design of self fixturing braze assemblies wherever possible.

2.0 GLOSSARY

LVS............................Low voltage starting.

Stinger........................Moveable electrode used for lamp ignition.

Mandrel........................A stainless steel tool which is polished to a mirrored surface with a special elliptical contour upon which the reflector is electroformed.

EI (characteristic)...........The voltage (E) across the lamp for a given current (I) passing through the lamp.

3.0 NARRATIVE AND DATA

The lamp is comprised of conventional tungsten electrodes positioned in a ceramic/metal structure with a reflector and sapphire window. The arc is located at the focal point of the reflector so that a directed beam is obtained coaxial with the electrodes. The low voltage starting mechanism includes a moveable electrode called the "stinger" which is coaxial with the anode. (Figure 1).

The lamp is filled with up to 20 atmospheres of high purity xenon at room temperature. The lamp's spectral output is a typical high pressure xenon arc spectrum as reflected from a silver mirror and transmitted through a sapphire window; the wavelength range is about 130nm to 6500nm. The silver reflector coating was selected for maximum output in the visible and near IR bands.

The lamp operating voltage is 19.5 D.C. $\pm$.5v. The lamp voltage is determined primarily by the interelectrode gap and the lamp pressure. The lamp acts much like a constant voltage device, that is, large changes in current result in small changes in operating voltage. Ignition is accomplished by use of the stinger. To commence the start cycle, the solenoid voltage is applied causing the stinger to move forward. The moment the stinger contacts the cathode tip, the electrical circuit is completed and current begins to flow through the choke. After approximately .4 seconds, the solenoid voltage is removed and the stinger starts to return to its deenergized position, thus breaking the circuit.

SECTIONAL VIEW OF MMTE LAMP

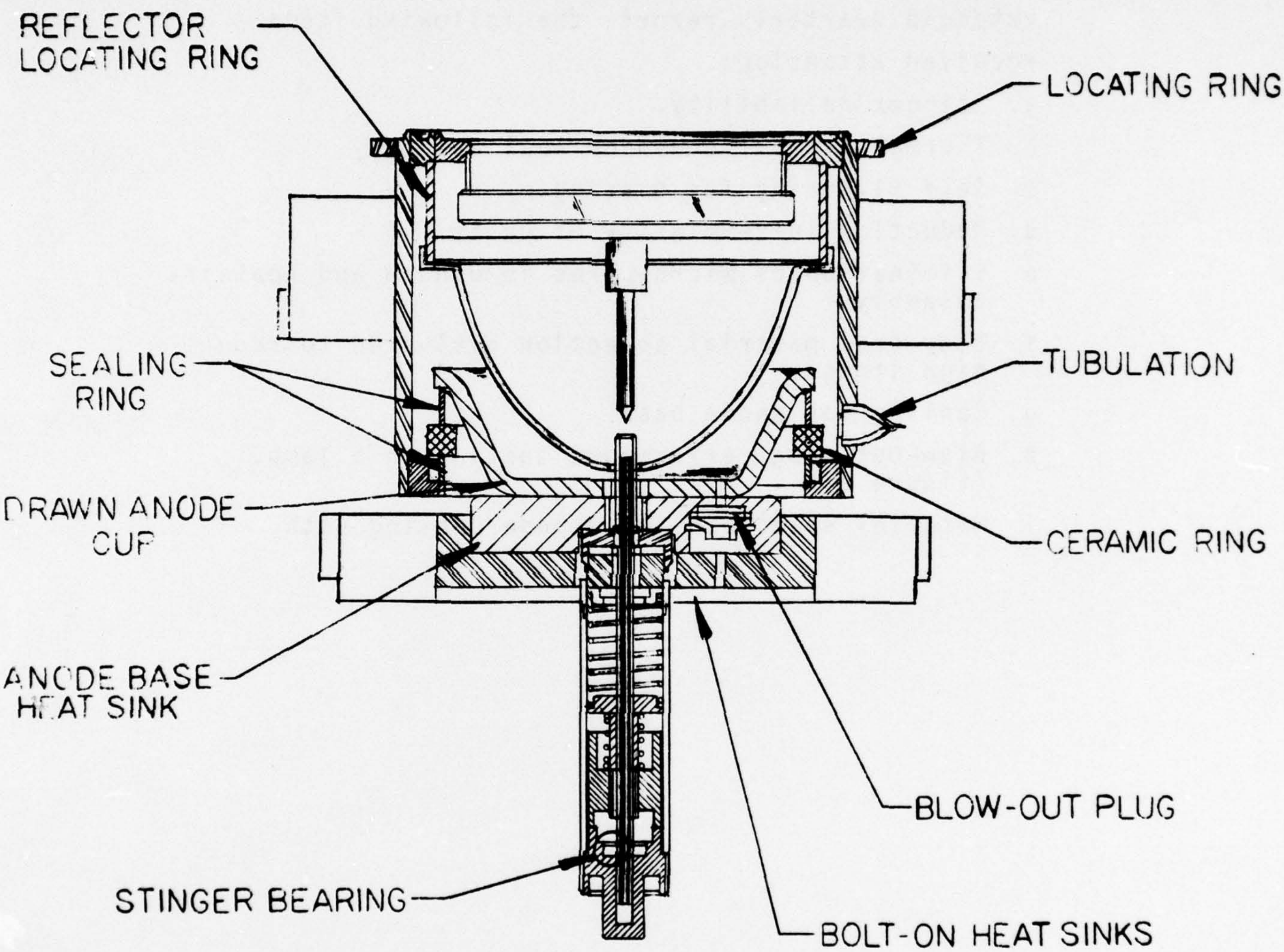
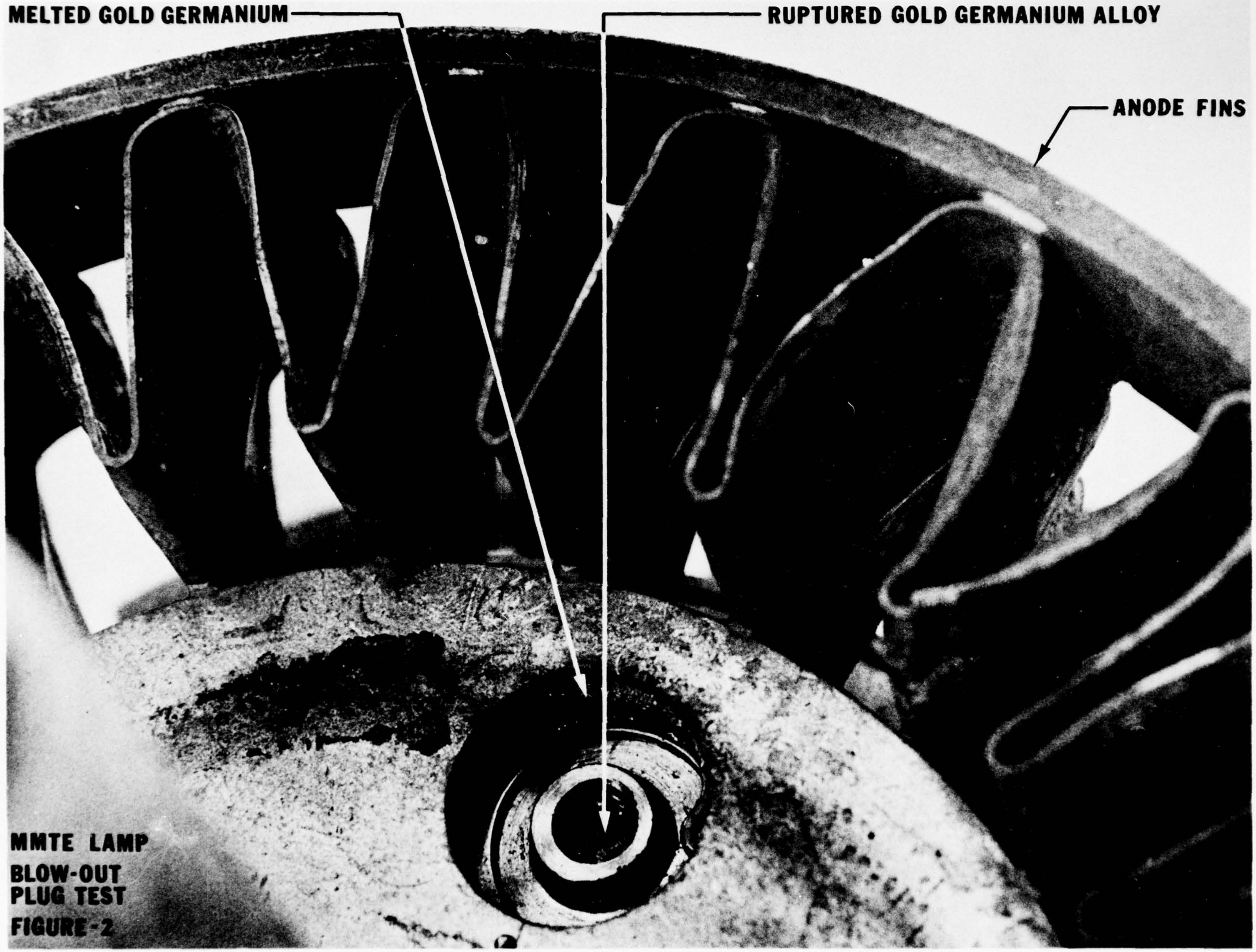


FIG.-1

At this time, the stored energy in the choke is dumped into the arc. The stinger then draws this arc back and transfers the arc to the anode. The lamp body underwent design modification to improve reliability and reduce manufacturing costs. During the time frame given for this extended quarterly report, the following items received attention:

a. Stinger reliability.
b. Thermal stress in window seal assembly.
c. Self fixturing for brazing.
d. Reduction in complexity of parts.
e. Elimination of micro-pores in window and heatsink assembly.
f. Body seal material selection evaluated to reduce high stress.
g. Cooling for anode base.
h. Blow-out plug performance testing in a lamp. (Figure 2).
i. Material selection in cathode cooling path.

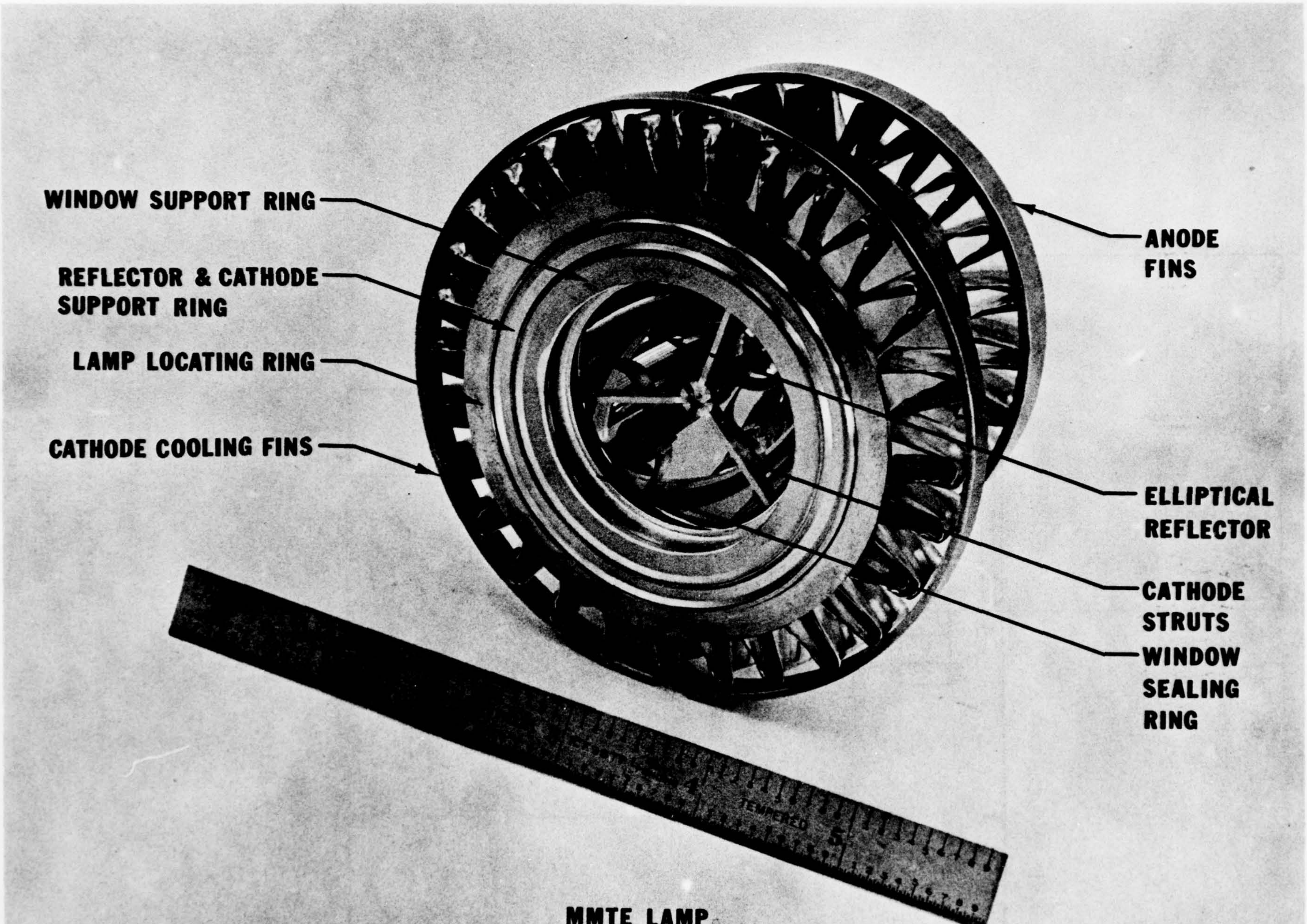


MMTE LAMP
BLOW-OUT PLUG TEST
FIGURE-2

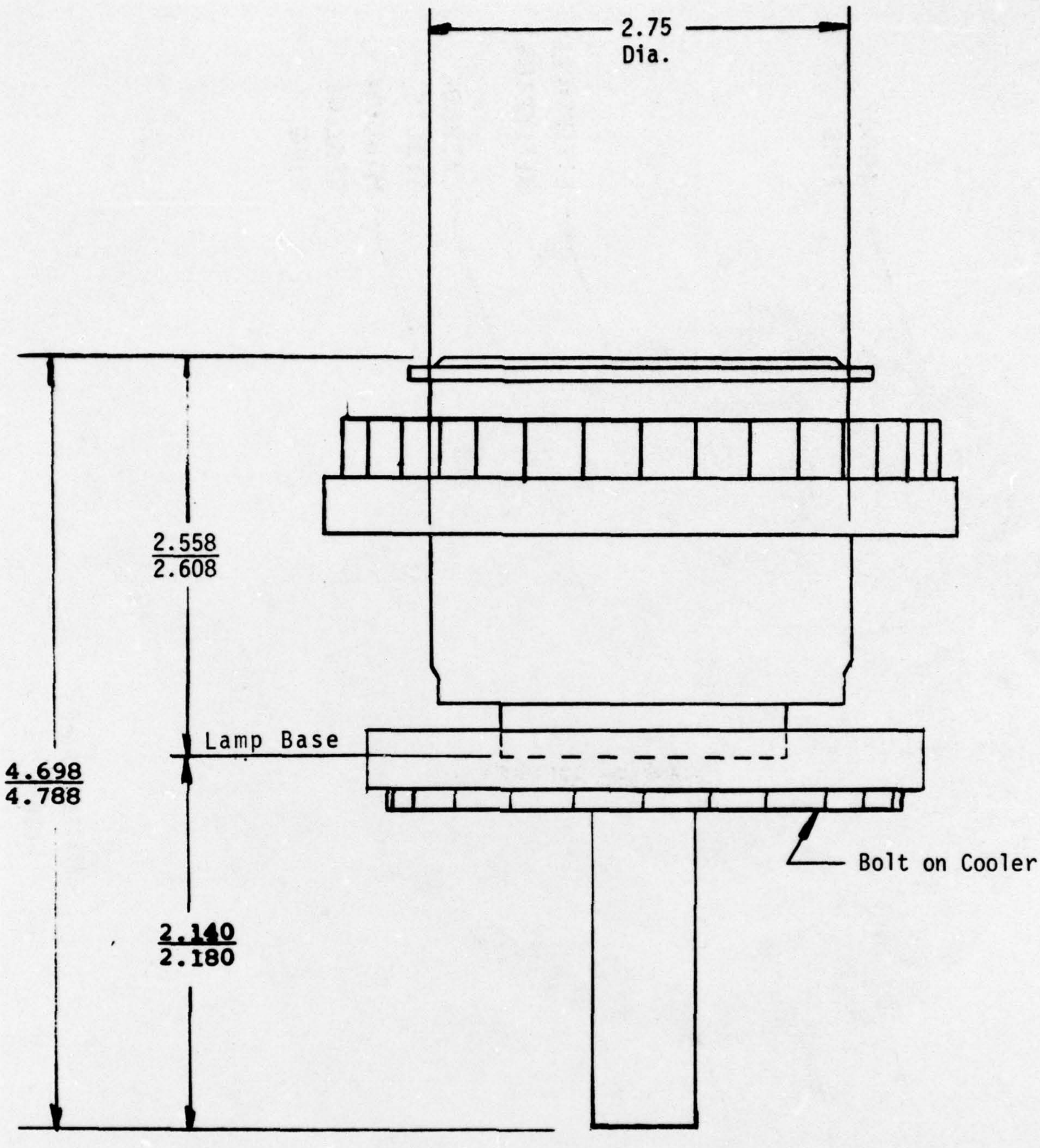
3.1 DESIGN AND ANALYSIS

The MMTE Lamp configuration is shown in Figure 3 and Figure 5. This lamp encompasses modifications as mentioned under paragraph 3.0. The reasons for the recent modifications are as listed below.

1. The window mount design was a highly stressed knife edge seal. The seal expansion mismatch was severe at copper braze temperatures. This mismatch seemed to increase the number of leakers. The problem of expansion mismatch was solved by pre-brazing the front window at a lower braze temperature and closely matching the expansion rates of joining members.
2. The main body ceramic to metal seals also caused problems with leaks especially during lamp bakeout. This problem was also attributed to expansion mismatches. Again, expansion rates of the adjoining materials were closely matched to alleviate this problem.
3. Porosity (micro-pipes) in the window and anode assembly presented problems in trying to attain a leak tight lamp.
   This porosity problem was minimized by using parts made with drawn and punched sections having porosity in a direction perpendicular to the lamps centerline (Figure 1).
4. Upon braze cool down the window sealing ring caused high stress at the joint interface. A new sealing ring is approximately 20% longer to adequately accomodate thermal expansion mismatch and thereby reduce excessive stress at the joining interface. (Figure 3).
5. The anode heatsink was operating at temperatures in excess of 200°C. The new design bolt-on heatsinks made totally of copper effectively remove heat



MMTE LAMP
FIGURE -3



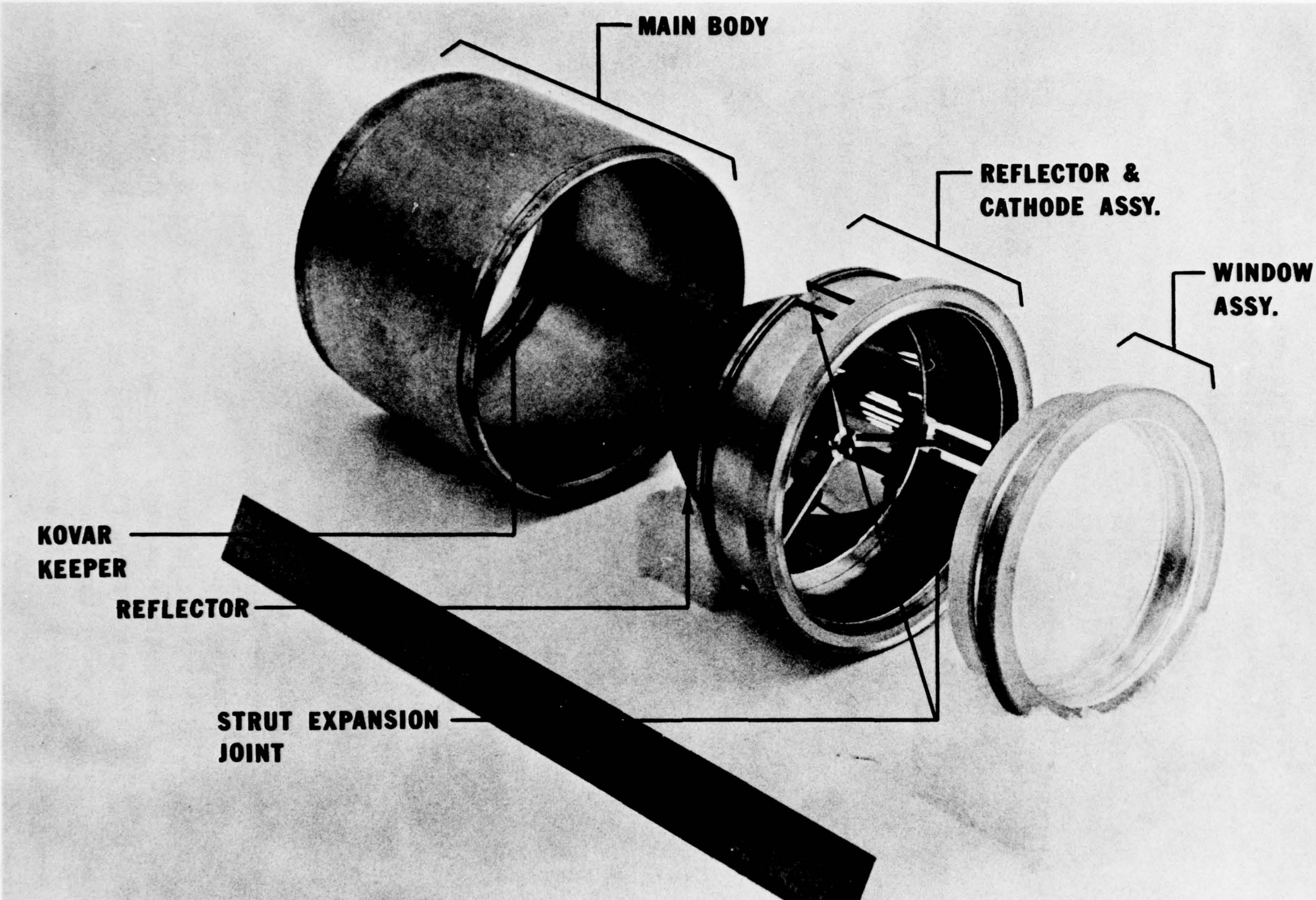
OUTLINE DRAWING SHOWING

MODIFIED LAMP BODY

FIG.-5

(Figure 1). The screw size to retain the heatsink has increased from 8-32 UNC to 10-32 UNF in order to increase the clamping load to aid heat removal.

6. The copper expansion pads on the cathode support rings were difficult to assemble in place. The new design has a cathode strut expansion joint integral with the reflector mounting assembly which reduce the number of parts required and decreases assembly time (Figure 4).
7. The heatsink base was difficult and costly to machine and the material waste was extensive due to large cavity recess required for the reflector. The cavity recess is now formed by brazing a Kovar cup to the anode heat sinks (Figure 4). This improvement should reduce manufacturing costs.
8. The lamp electrode gap spacing was previously set at .085/.090. At the 1kw power level this setting resulted in EI characteristics falling outside specifications after a few hundred hours running time. The new gap spacing is based on the 6257 lamp design to enable future lamps to fall into MMTE specifications.
9. The blow-out plug parts and assembly costs were reduced by minimizing the total number of parts required. Gold Germanium preforms are on order for the confirmatory project stage.
10. The stinger mechanism was slightly modified to incorporate the following features.
    a. A larger hole was drilled thru the insulating ceramic surrounding the stinger. This improvement should reduce outgassing time required during lamp processing.
    b. The stinger mechanism was evaluated for function. The outcome of this evaluation resulted in opening stinger bearing clearances to avoid binding.
    c. In order to reduce the solenoid voltage that operates the stinger, it was necessary to incorporate



MMTE LAMP
PARTIAL EXPLODED VIEW
FIGURE - 4

the stinger armature used for the 6257 lamp. This resulted in lowering the activation voltage from 18 volts to 16 volts.

3.2 FABRICATION

Parts preparation for the confirmatory stage has progressed very well during this time period. Most parts are available for completion of the MMTE contract confirmatory phase. Parts still outstanding include:

a. Electroformed reflectors.
b. Blow-out plug preforms.
c. Additional tooling required (approximately 80% complete).

3.2.1 TOOLING FOR BRAZING

Braze assembly tooling for the confirmatory phase also progressed very well. Among the tooling completed for brazing the next three engineering samples include:

a. Tooling for front window keepers to align sealing ring and front mounting flange concentric with sapphire window.
b. The cathode to strut alignment tooling.
c. Reflector support ring tooling for locating the cathode strut assembly concentric to reflector locating flange (Figure 1).
d. The main body assembly tooling for locating the body in Figures 1 and 4 concentric to the main body ceramic, sealing rings and the anode base heatsink.
e. Tooling for the cathode and anode cooling fin assembly.
f. The stinger mechanism alignment tooling.
g. Tooling to properly hold the blow-out plug during brazing.
h. Necessary braze keepers to limit expansion growth of braze members.

All remaining parts requiring brazing are designed for self jigging.

3.2.2 TOOLING FOR PARTS MANUFACTURE

Tooling required to Hydro form press the drawn anode cup in Figure 1 is complete. In addition tooling is complete for:

a. Body and window seals were fabricated from drawn kovar cups and machined to length.
b. Spring mandrels for forming stinger springs for confirmatory phase.

Tooling still outstanding include:

a. Window ring flanges will be punched out from flat stock and machined to size.
b. Tooling to aid the final Heli-arc body seal.

3.3 TESTING

The testing performed on the MMTE lamp during this period is as follows:

a. The blow-out plug was inserted into a lamp to record reliability in depressurizing the lamp. The lamp was operated at the 1kw level for 15 minutes before shutting off the fan. After approximately two minutes of operation, the blow-out plug safely depressurized the lamp. (Figure 2).
b. The main body seals were thermally cycled to determine if a leak would develop. The results of the tests showed a leak tight joint is obtainable with the present design configuration.

c. Voltage and current tests were performed to actual operating conditions. Previous engineering samples tested revealed voltage readings of 21 to 22 volts at the 51 amperage level. The present engineering samples tested generated a much flatter curve at the 51 amp level. This is attributed to the gap spacing changed from $\frac{.085}{.090}$ inches to .065 inches which closely matches the 6257 lamp presently used for searchlight applications.

d. The stinger mechanism was tested to determine optimum voltage levels required to reliably operate the stinger. This range was 15 to 16 volts which is still within the 18 volts maximum specification.

e. The 3rd engineering sample for this period was tested and was unable to fully meet MMTE contract specifications for PBC and EI characteristics. The lamp developed a leak at the stinger ceramic to metal seal which partially accounted for the low photometric lamp output.
An extensive study effort was undertaken to prevent a reoccurence of this problem. This seal was found to require additional flexability in order to reduce excessive stress. A quick solution to this problem is obtainable and will be rapidly incorporated into the overdue 3rd engineering sample.

3.4 CONCLUSION

Lamp parts were fabricated and subassemblies are underway to complete the 3rd engineering sample phase. Additional parts are available to start confirmatory stage assembly. Tooling is being verified for function by the 3rd engineering sample. Additional sets of tooling for the confirmatory and pilot production run will be available shortly. Photometric performance to meet MMTE specification was not achieved with the previous 3rd engineering sample as noted above.

4.0 PROGRAM FOR NEXT INTERVAL

1. Deliver the 3rd engineering sample and test report.
2. Start fabrication for the confirmatory sample phase.

5.0 PUBLICATIONS AND REPORTS

None

6.0 IDENTIFICATION OF PERSONNEL

The following is a list of the key personnel who worked on this contract during the period March 1977 through September 1977.

Roy Roberts	296.0 Hours	
Ed Chan	123.0 Hours	
Gordon Liljegren	28.0 Hours	
Charlie McGlew	318.5 Hours	
Nick Picoulin	63.5 Hours	
Welton Jones	158.5 Hours	
Nick Cortese	62.5 Hours	(Technician)
Svet Danich	11.5 Hours	"
Scott Flackman	3.3 Hours	"
Bob Runyon	3.6 Hours	"
Cheryl Handley	18.2 Hours	(Draftperson)
Greg Guild	2.2 Hours	"
Glenn Brown	1.0 Hours	"
Paul Wierenga	7.0 Hours	"

Manpower setbacks were experienced due to departure of key personnel (Program Manager, Ed Chan and Master Technician, Charlie McGlew) which were heavily involved in the MMTE project from the beginning.

The resume for Welton (Skeets) Jones is included in this report. Skeets is a Master Technician with EIMAC and is devoting full time to the MMTE project.

The new Project Engineer for the MMTE project is Roy Roberts. His resume was included in the 2nd quarterly report.

Welton R. "Skeets" Jones

Joined EIMAC February 1942

Built Tube processing equipment

1943 Appointed Head of Punch Press Department.

1944 Added Grid Department

1945 Added Plate Department

1954 Appointed Head of Ceramics processing and Assembly
Ceramic Coating/Brazing etc.

1955 Organized Production machine shop parts fabrication.

1960 Due to divisionalization-appointed to circuit and
components div.- Tuning cavities and circuitry.

1962 Appointed Master *Technician in* Aero Space division
experimental cavities and tuning equipment.

1968 Transferred to Advance Products to process and assemble
lunar docking lights.

1969 Started on xenon arc lights
2kw light
Tow lights etc.

1973 Completed P.E.M. Light project
Special tubes-grid configuration

1976-1977 Assembled switch tube modules and modules into tube frame

All of the above require soldering, brazing, spot welding
and arc welding.

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